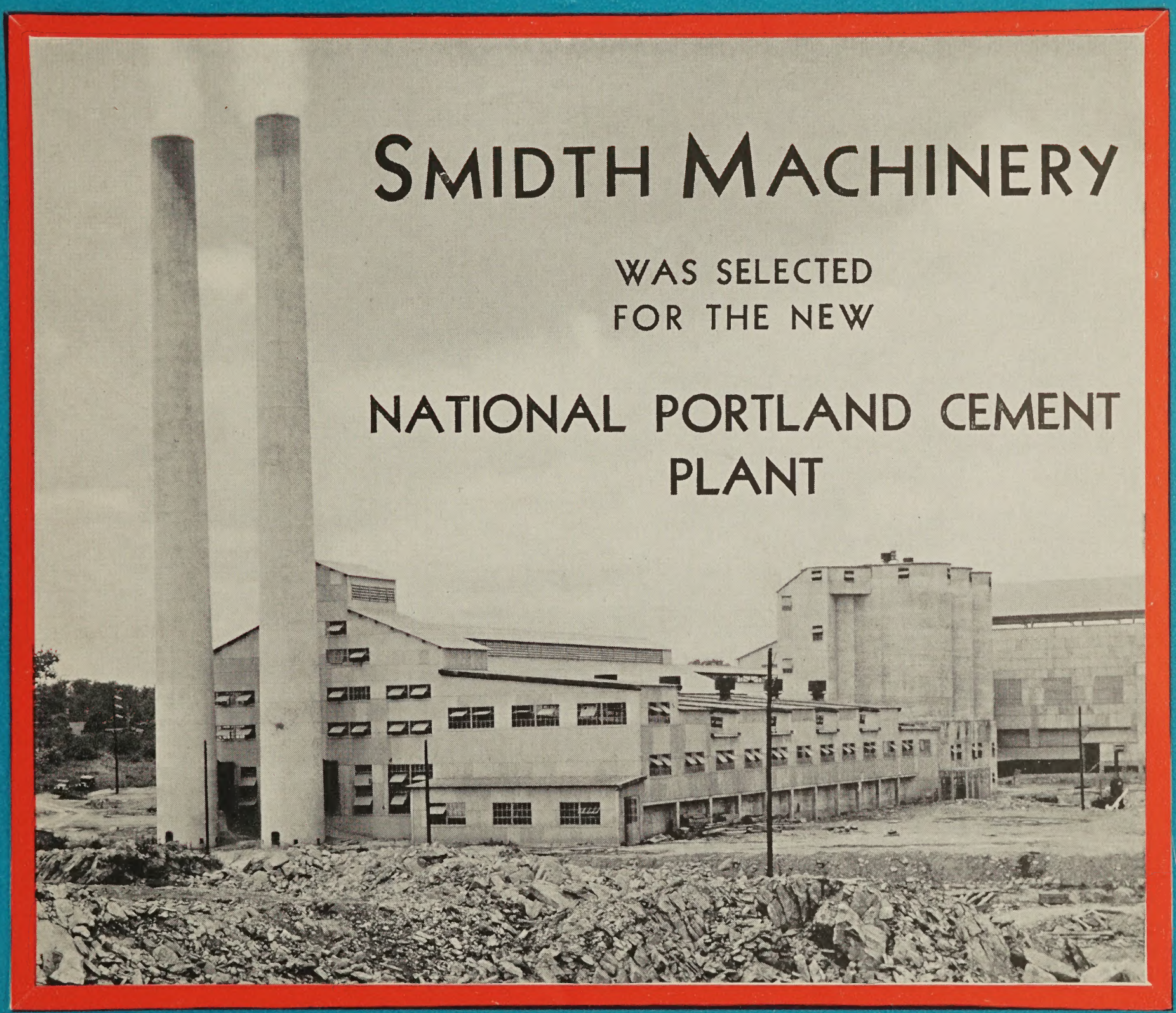

SMIDTH MACHINERY
WAS SELECTED
FOR THE NEW
NATIONAL PORTLAND CEMENT
PLANT

Reprinted from

ROCK PRODUCTS

AUGUST, 1935

for

F. L. SMIDTH & CO.

225 Broadway, New York, N. Y.

Recently Completed Plant of the National Portland Cement Company, Brodhead, Penn., Is Receiving Many Visitors from at Home and Abroad

—Courtesy Dallin Aerial Surveys, Philadelphia, Penn.

This aerial view clearly shows the relative positions of the various units of the plant.

World's Newest Cement Plant

By George M. Earnshaw

THE NEWEST cement plant in the Lehigh Valley was built over the protests of the organized industry as an unnecessary addition to a large unused capacity. The leading figure in the organizing and promotion of the company and the building of the plant is the well known Fred B. Franks, Sr., whom the cement industry has come to recognize as possessing a remarkable special aptitude and organizing ability in the promotion of cement plant projects. The National plant is the fifth one built by Mr. Franks.

It is not the purpose of this article to discuss the economics involved; the plant has been completed; it is operating to capacity; it is being visited by cement manufacturers from this country and from all over the world. Those responsible for its completion and present operation will undoubtedly use it as a demonstration plant, where this new machinery and processing will be thoroughly tested.

It was to be expected that this new plant would be "different, most modern and highly efficient," if for no other reason than that it is the first new one built in the United States in the last six years. Such expectations are justified, for the now finished plant and operation as a whole is different from any other in this country and is as modern and efficient as some of the world's best designers, engineers and machinery manufacturers could produce.

The first of the two kilns was fired on March 15 and the second on April 15, this year. Since the latter date, daily production of finished cement has averaged 3,600 bbl., which is the rated capacity. However, the plant has produced as high as 3,800 bbl. in a day. As for the quality of the cement, the following tests tell their own story. They were made on June 23.

The above tests were approximately average of those taken during the two weeks previous. Daily variations were unusually slight.

Quarry and Crushing Plant

The quarry was opened as near the crushing plant as possible and at present its floor is about 60 ft. below the floor level of the crusher house. Remarkable speed has been made in the development of the quarry, which eventually will have a working face about 75 ft. high and several hundred feet long. The stone deposit has a clay overburden averaging from 5 to 10 ft. in thickness, which at this time is being trucked to a dump storage, later to be reclaimed and processed. Due to the newness of the quarry at this time, there is sufficient clay naturally mixed in the stone, making it unnecessary to handle and process clay separately. The

SLURRY

	Raw Mill	Kiln Feed
Fineness through 200-mesh	91.3%	92.2%
$CaCO_3$	77.9%	76.5%
% H_2O	35.7%	37.0%

CEMENT

Physical

Fineness through 200-mesh	99.3%
Fineness through 325-mesh	93.0%
Specific surface	1847
Soundness	O.K.
Initial set	3.40 hr.
Final set	5.45 hr.

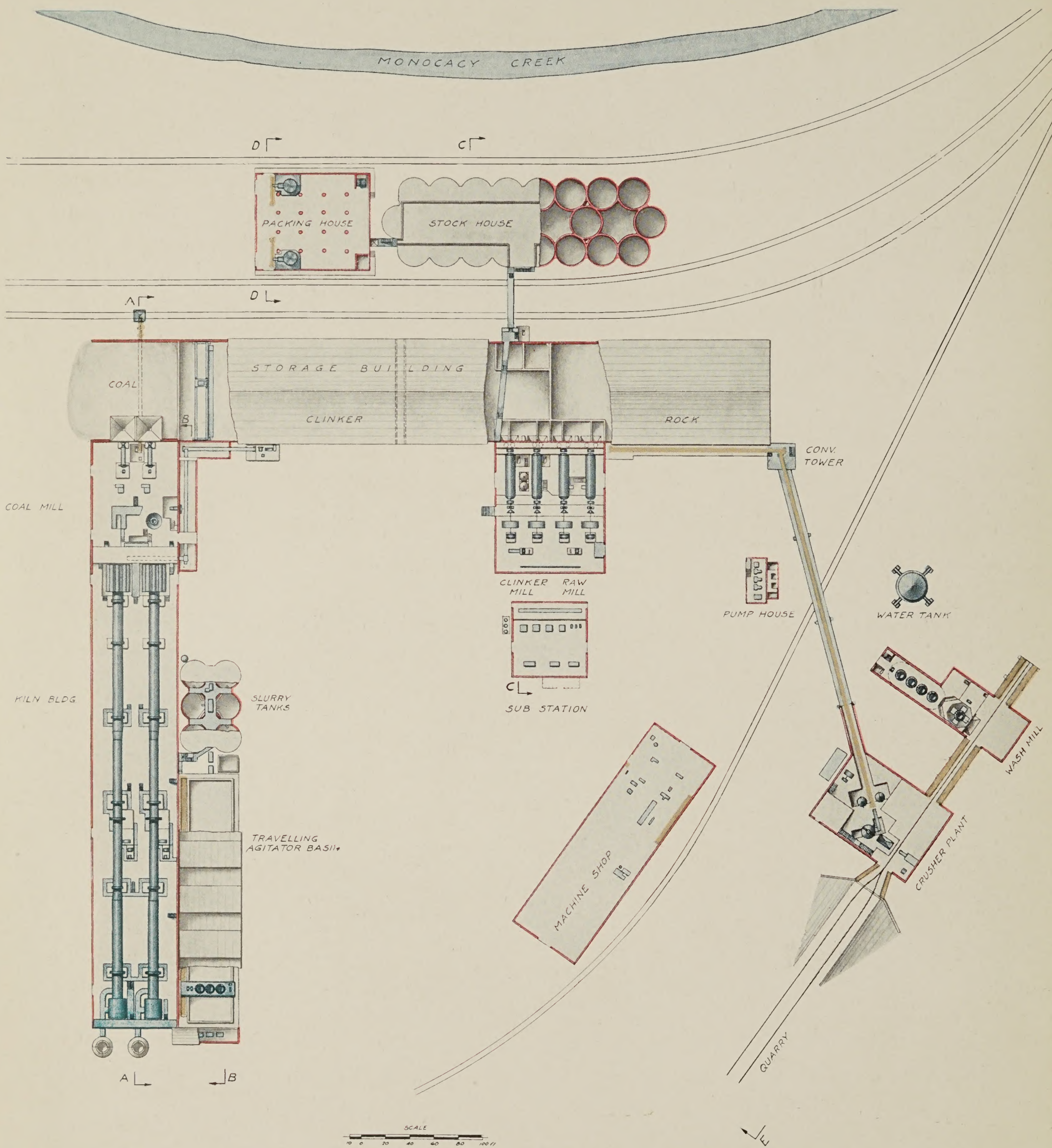
Tensile strength

1 day	205
3 day	333
7 day	390
28 day	488

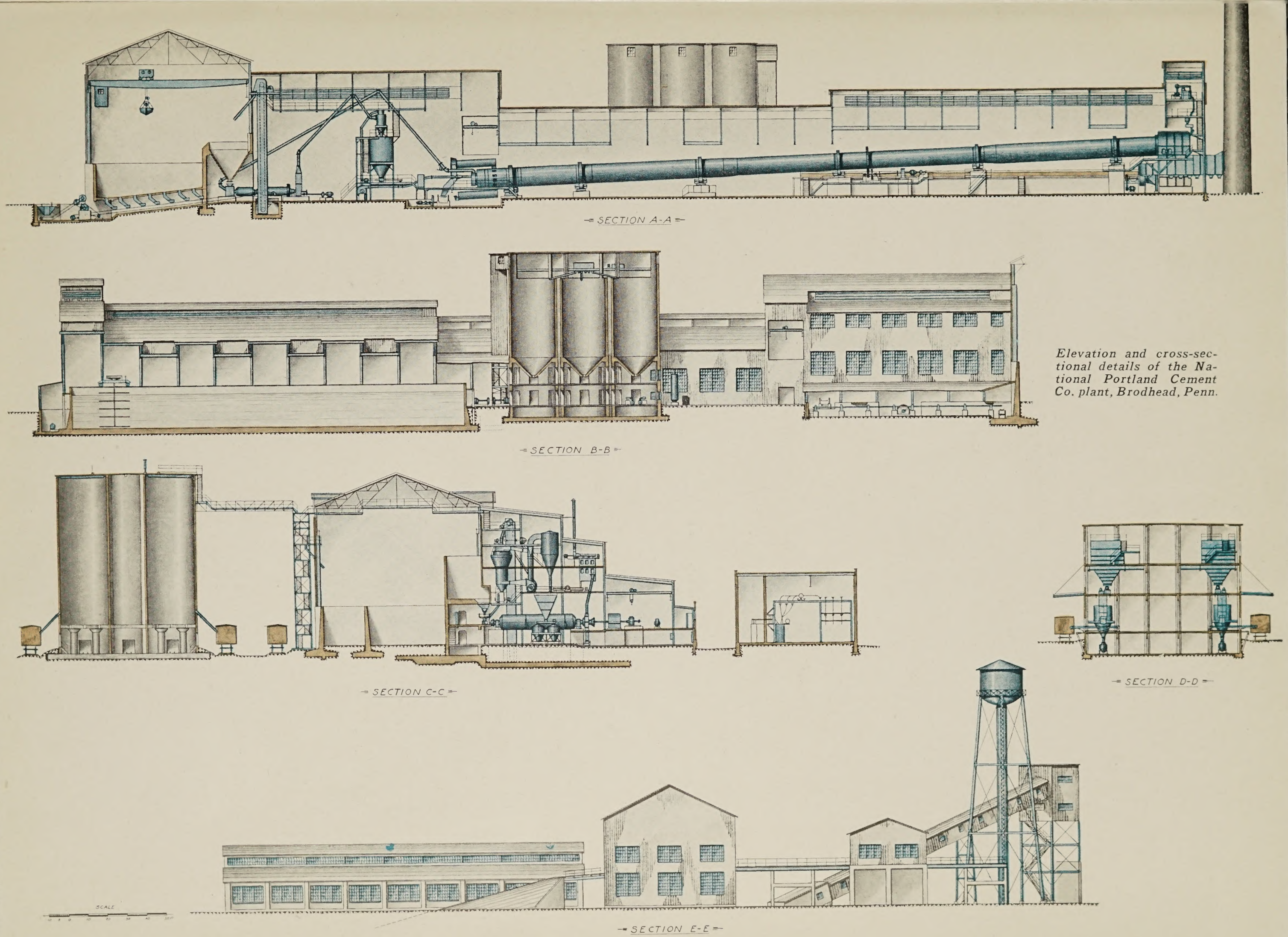
Chemical

SiO_2	22.00%
Al_2O_3	4.91%
Fe_2O_3	2.45%
CaO	63.95%
MgO	2.83%
SO_3	1.76%
Loss	1.24%
Total	99.14%

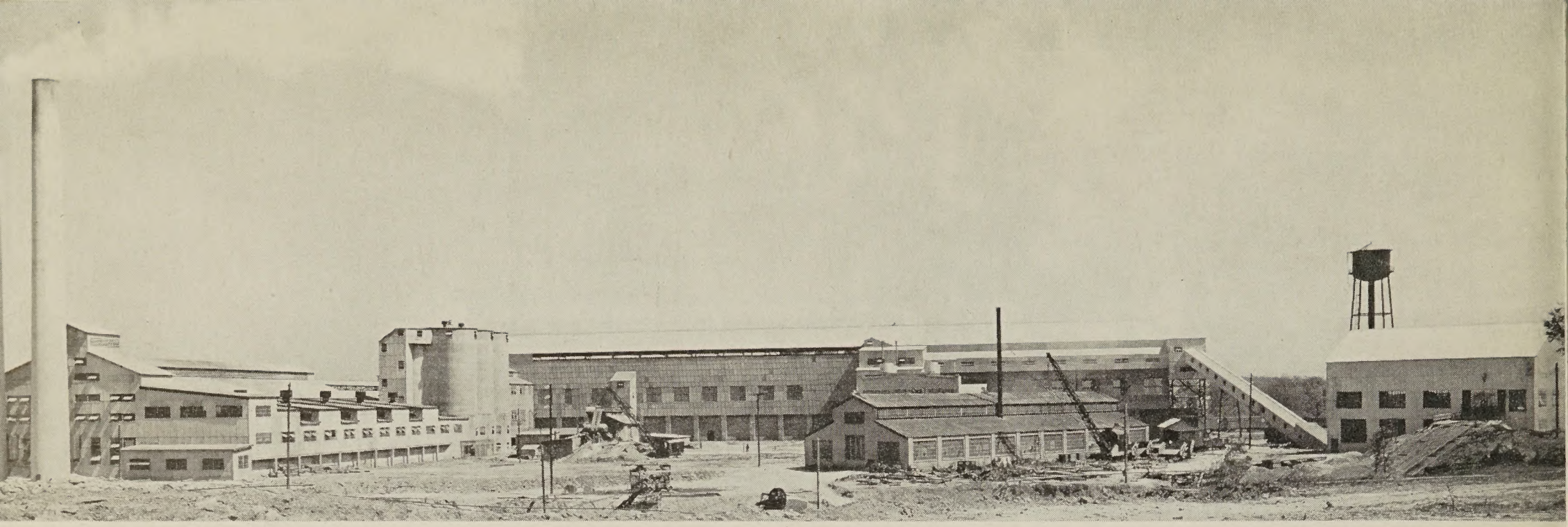
Silica ratio	2.99
Lime ratio	2.18



Plan of the plant of the National Portland Cement Co., Brodhead, Penn.



Elevation and cross-sectional details of the National Portland Cement Co. plant, Brodhead, Penn.



View of the plant from top of quarry face. Crushing plant at right; center foreground, the machine show; center, rear 550-ft. long general storage building; and at left the kiln building, slurry silos and storage basin. The cement silos and packhouse, not shown, are behind the storage building

mixed stone and clay are loaded by two P. & H. electric shovels with 2-yd. dippers. A fleet of twelve 8-yd. Atlas steel cars and a 12-ton Vulcan locomotive handles these raw materials between the quarry and the incline to the crushing plant on standard-gage track. The major drilling is done by contract with Keystone and Armstrong blast-hole drills, and secondary drilling with Ingersoll-Rand "Jackhamers." Air for the secondary drilling and for agitation in the clay storage basin is furnished by a two-stage, 250-c.f.m., Fuller rotary compressor. At the time of our visit, Atlas explosives were being used.

Crushing and Screening

The crushing and screening plant, while new and modern in every respect, is more or less of the conventional design. Cars of stone or clay are pulled up the incline one at a time to the crusher floor level by a double-drum Vulcan hoist. They are dumped by an Easton Car & Construction Co. automatic dumper, operated by a small Lidgerwood hoist, into a steel hopper. A 48-in. pan feeder is the connecting link between the hopper and primary crusher. The latter is a No. 36 Kennedy-Van Saun gearless gyratory. The pan feeder, bucket elevator, screen and secondary crushers were also furnished by Kennedy-Van Saun.

The primary crusher is set to discharge at 8 in., and its product flows to a chain-roller elevator to a vibrating screen. Rejections from the screen flow to one compartment of a 2-compartment bin, and the product of the screen into the other compartment. The over-size is fed to two No. 49 secondary gyratories and the material from them, and that passed through the vibrating screen, feeds to an inclined 36-in. Jeffrey belt-conveyor, 300 ft. centers, leading through an enclosed gallery to the general storage building. Here another 36-in. belt conveyor distributes the stone to any desired point within the conveyor's 180-ft. length, by means of an automatic tripper. The end of the distributing belt is directly over the raw mills' feed bins so that the bins can be filled directly from the conveyor, thereby eliminating extra handling.

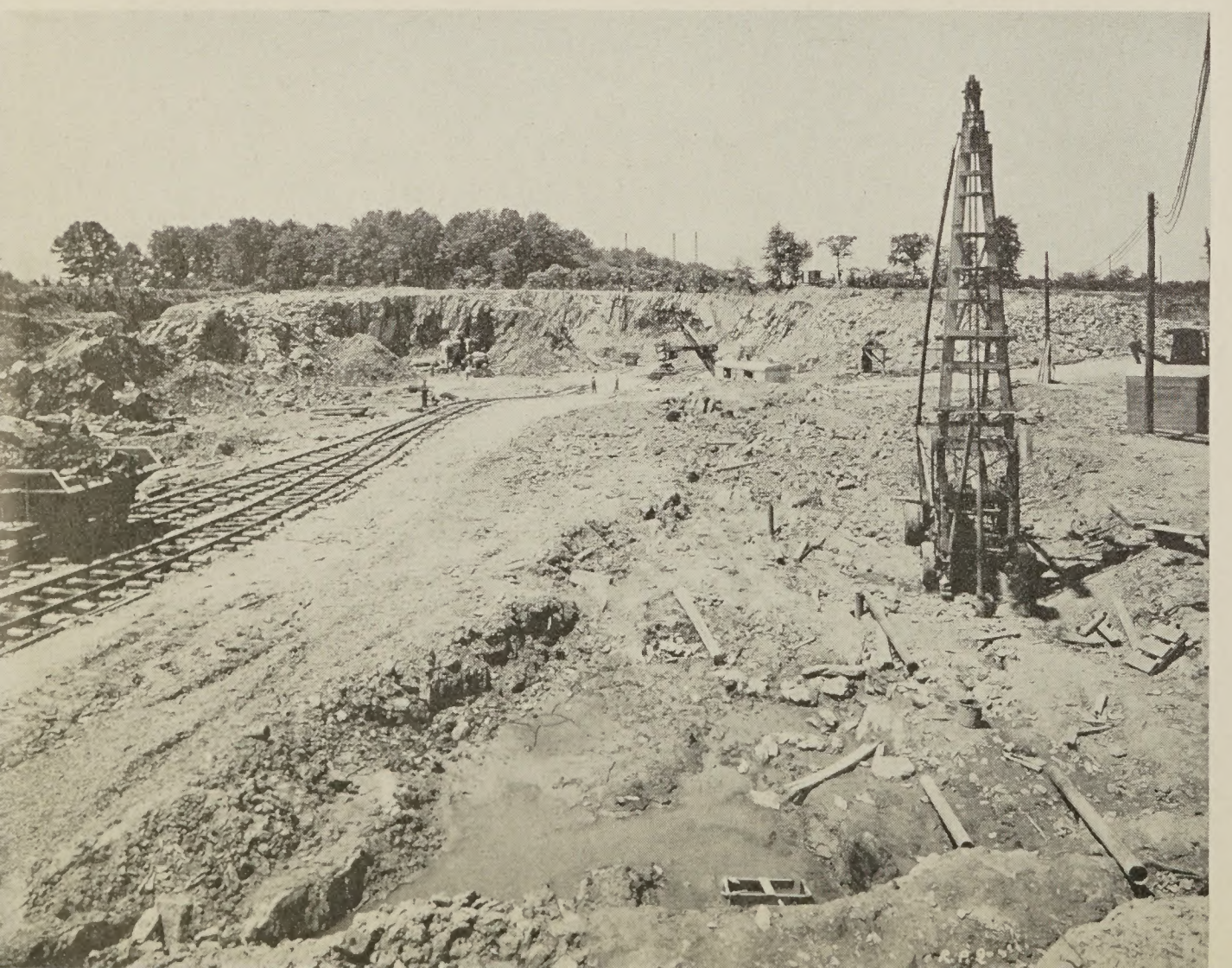
The clay-processing plant is beyond the crushing plant, from the quarry, and cars of clay will be pulled through the crusher house to it. This plant consists of a 24-ft. F. L. Smidth Co. wash mill with mechanical agitation. From the wash mill the clay flows, with a 60% water content, to a 50x20x20-ft. storage basin, also equipped with mechanical agitators in addition to compressed air agitation. From this basin the clay is moved by a 3-in. Wilfley pump to Smidth scoop feeders serving the raw grinding mills.

Cement Plant Proper

The accompanying photographs and drawings comprise in themselves an almost complete description of the plant and for that reason the following text matter will be confined only to description not readily seen in the illustrations.

The general storage building is 550x80 ft., divided in the usual way for the various materials, including separate sections for high-lime and low-lime stone. The crane is a 10-ton P. & H. with 3-yd. Blaw-Knox bucket. Each of the two raw mills has two stone bins; one for high- and one for low-lime stone, 400 tons each. The material is fed to the raw mills by standard Smidth table feeders. The mills are 8x36 ft., 4-compartment, and carry a charge of 60 tons of grinding media. There are four mills; two each for raw and for finish grinding. The former are driven by 800-hp. synchronous motors and the finish mills by 900-hp. motors of the same type, through Smidth Symetro Drive speed-reduction units. The motors, reducers and main switchboard are housed in a separate room, which also houses a 400-hp. Hall-Scott gasoline engine emergency unit, which has sufficient capacity to keep the kilns turning while cooling; to furnish power for slurry agitation and to furnish lighting, in the event of power failure from the outside. Incidentally, both raw and finish grinding is done at night in order to avoid peak-load power rates. All motors and electrical equipment in the plant were furnished by Westinghouse, whose engineers

Below: The quarry as seen from foot of the incline. The shovel at the right is working toward the drill in the foreground at a lower level



worked with the E. M. Gilbert Engineering Corp. in the design and installation. An exceptionally interesting feature of the National plant is its electrical layout. At a later date we expect to publish an article on this phase alone, complete with electrical details covering the entire plant.

Slurry is pumped from the mills to blending silos via a distributing box by a 6-in. Wilfley pump. A similar pump is installed as a stand-by. The silos, of which there are six, are 22 ft. diameter, 40 ft. high and hold 1400 bbl. each. Blending is accomplished by drawing the slurry from the silos to a sump from which another 6-in. Wilfley pump transfers it to another compartment of the distributing box above the silos. The properly blended slurry is then fed to a 35x 200-ft. rectangular concrete storage basin, 21 ft. deep. This basin provides storage for approximately 16,000 bbl. It is equipped with a Smidth traveling agitator with three paddle shafts. Compressed air is also used for agitation. From here the slurry is transferred by two 3-in. Wilfley pumps to the kilns via Smidth scoop feeders driven by variable-speed motors, which operate synchronously with the kiln motors. An arrangement of valves permits the pumping of slurry, when desired, from any one of the blending silos direct to the kilns, by-passing the storage basin.

The two kilns are Smidth Unax units with integral coolers and are 372 ft. long. The end sections are 10 ft. in diameter while the center section, about 125 ft. long, is 9 ft. in diameter. The kilns are mounted, with a pitch of ½ in. per foot, on six tires, each of which runs on oil-lubricated adjustable-bearing rollers. The rollers operate in a water-cooled oil bath. Thrust rollers are mounted at the fourth tire and near this tire is the drive ring gear which is attached to the kiln by spring plates. A d.-c. adjustable-speed motor is used for driving each kiln. This motor is capable of developing 33 hp. at its lowest speed, and 100 hp. at its highest speed. However, the actual power consumption is only about 45 hp. Each motor is connected to a Smidth speed reducer and each motor is equipped with a solenoid brake to prevent rocking of the kiln when the power is turned off. Slurry feed is controlled in proper relation to the speed of the kiln by means of a Smidth sending unit mounted on the drive shaft of the kiln motor. These units generate current for the adjustable-speed 3-hp. motors driving the slurry feeders. At the time of the writer's visit the kilns were running at the speed of one revolution every 53 sec. The power consumption per kiln averages 45 to 50 hp.

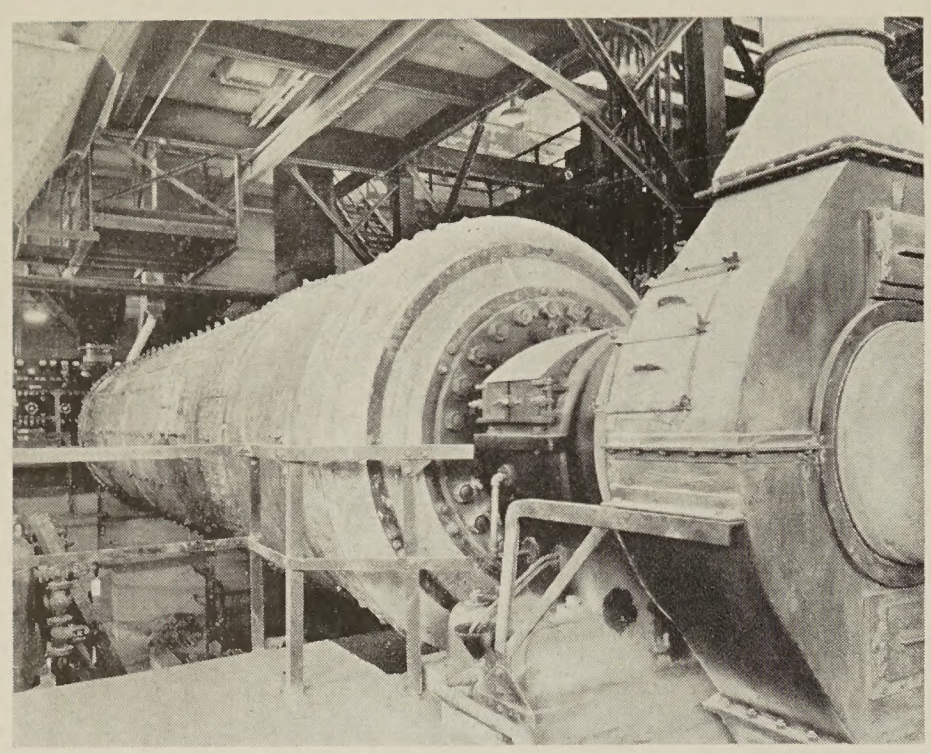
Stone crushing plant, showing trackage arrangement and type of haulage equipment serving it

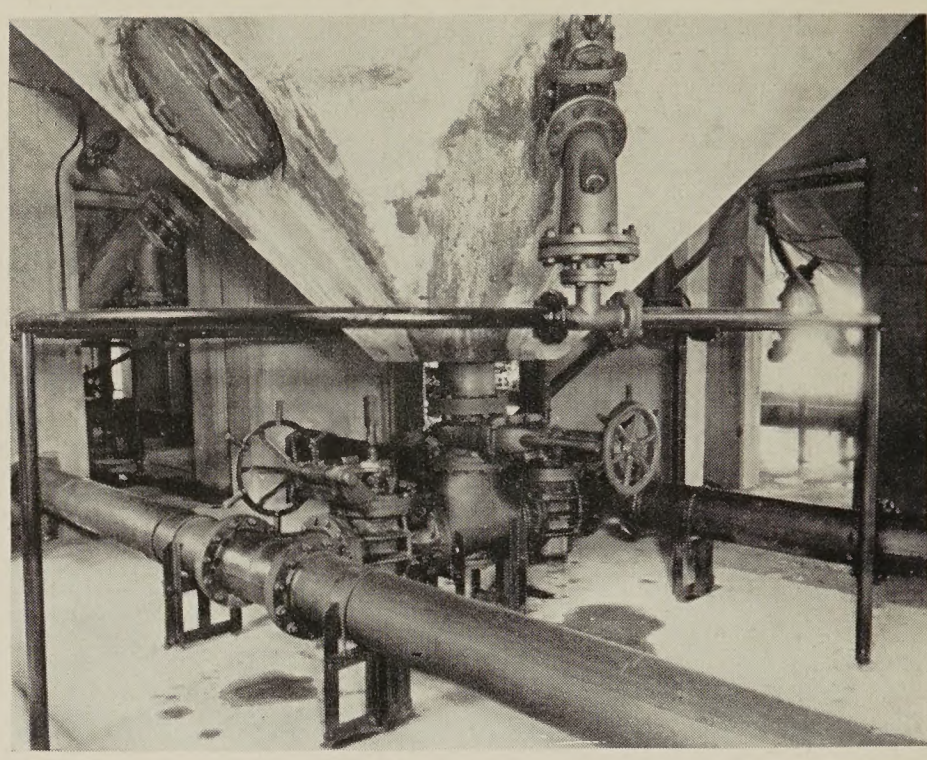
The temperature of the kiln gases entering the stacks is reduced to an average of about 450 deg. F. and this low temperature is attained largely due to the chain system in the feed end of the kilns. Chains are fitted in the kilns for a distance of 76 ft., their function being to hasten the heating and absorption of the slurry and to prevent the formation of rings, with a consequent reduction in temperature of exit gases. The kilns are equipped with draft fans and motor-operated dampers. Gases pass through dust chambers to the stacks, which are 175 ft. high and 8-ft. inside diameter at the top. These were built by the Alphons Custodis Chimney Construction Co., are of concrete construction designed for earthquake stress and are lined their full length with a self-supporting brick lining.

Coal Plant

Coal is dumped from railroad cars into a track hopper and from there it is moved by apron conveyor to hammer mill, to belt conveyor, to inclosed bucket elevator to storage or direct to the 100-tons capacity concrete bins over the two coal mills. Jeffrey Manufacturing Co. furnished the hammer mill, conveyors and elevators. The coal mills are Smidth Tirax combination drying and grinding units and have a capacity of six tons per hour. Smidth fans draw the hot air for

Below: As the plant looks from the office building. From left to right, cement silos, packhouse, raw materials storage and kiln building





Left: One of the four 8 x 36-ft. four-compartment tube mills. Right: Close-up of valve arrangement under one of the slurry blending silos

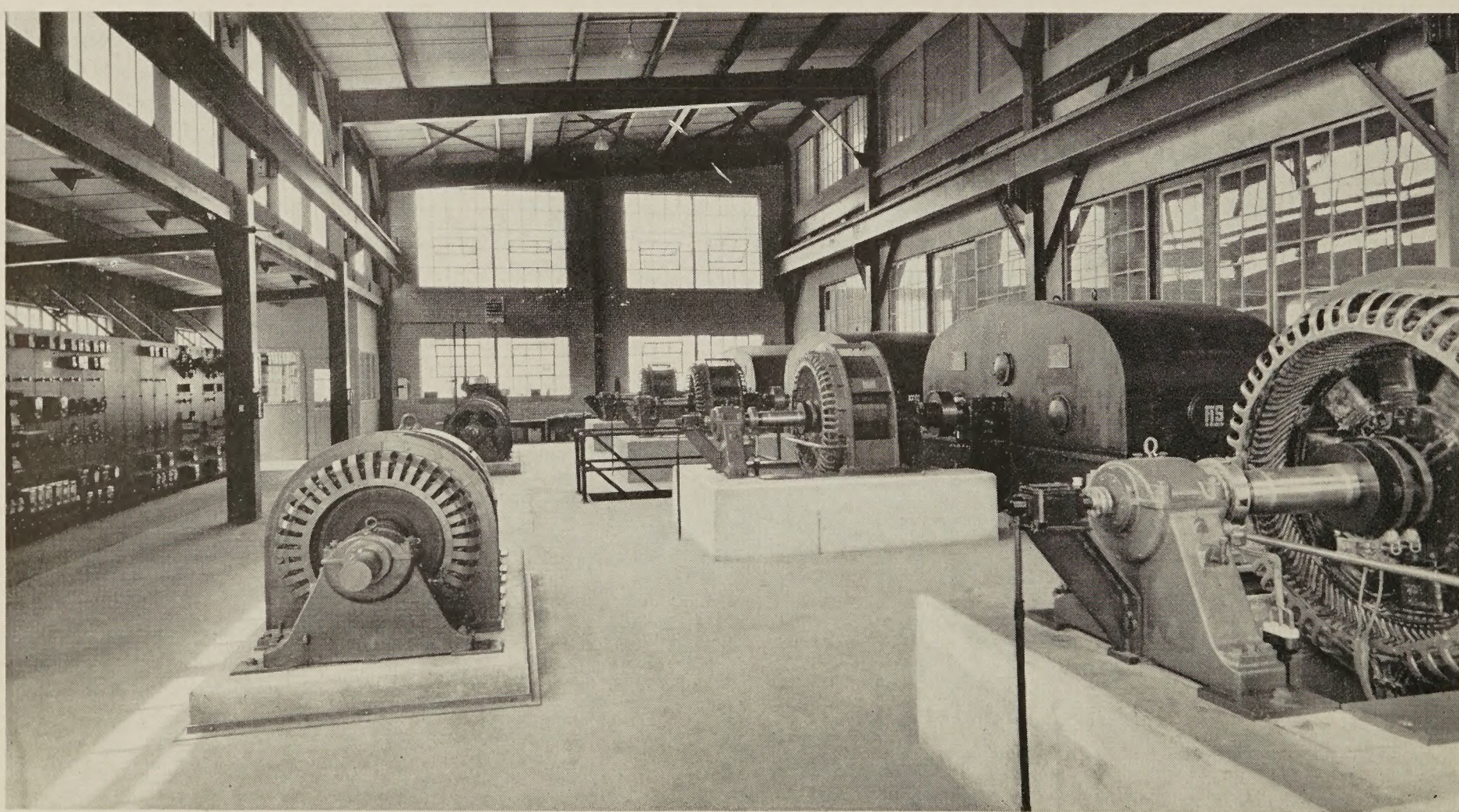
the mills from the kiln hoods at a temperature of approximately 350 deg. F. This air is reduced to about 120 deg. at exit from the mills. These same fans move the pulverized coal from the mills to two cyclones from which it is discharged to two 20-ton bins serving double-screw feeders to the kilns.

During the month of June the moisture in the coal fed to the mills was 3 to 5%, and that produced by the mills contained from 0.4 to 1.0% with a fineness of 93.04% through 100-mesh. Each mill ground and dried 9250 lb. of coal per hour. The power consumption for each mill was 87.4 hp. During this period the company found it unnecessary to grind the coal down to the above mentioned fineness, and since July 1 the production of each mill has been raised to 12,200 lb. per hour with a fineness of 90% through 100-mesh, with the same power consumption.

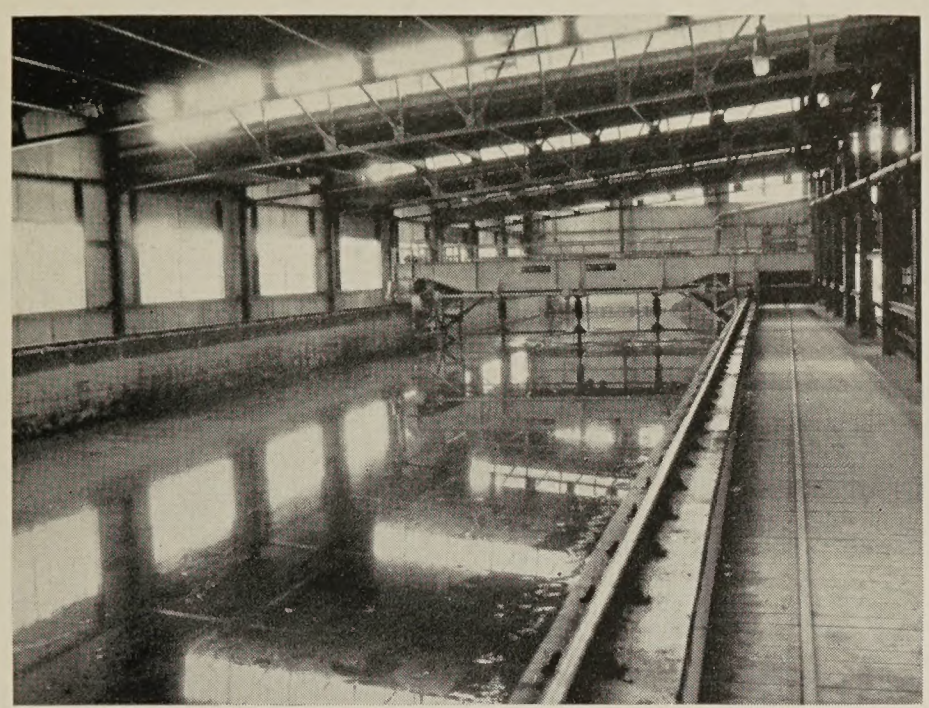
Fuel consumption varies from 900,000 to 1,000,000 B.t.u. per bbl. of finished cement. One specific test showed that with 13,500 B.t.u. coal, the consumption was 69.7 lb. of coal per bbl. of cement, with a slurry moisture of 36.7%. It is expected, after the plant is thoroughly "run in," that moisture will be reduced to 34% with a consequent further reduction in fuel consumption.

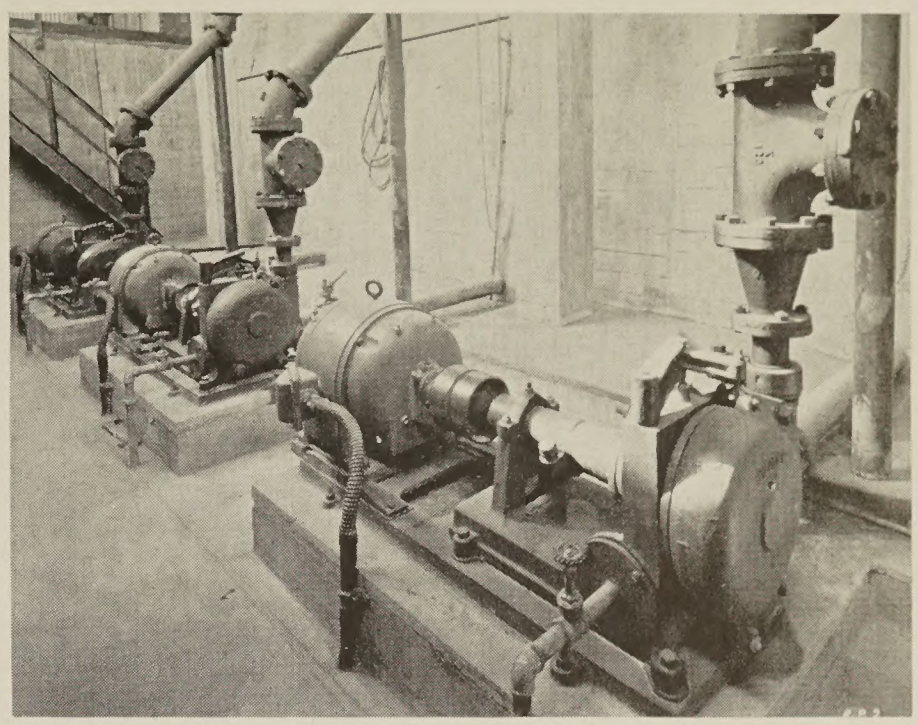
Clinker Handling and Finish Plant

The Smidth Unax clinker cooler on each kiln consists of 10 drums mounted around the discharge end of the kiln, each drum containing suspended chain for the agitation and consequent lowering of temperature of the clinker. The average temperature of clinker entering the coolers is around 2000



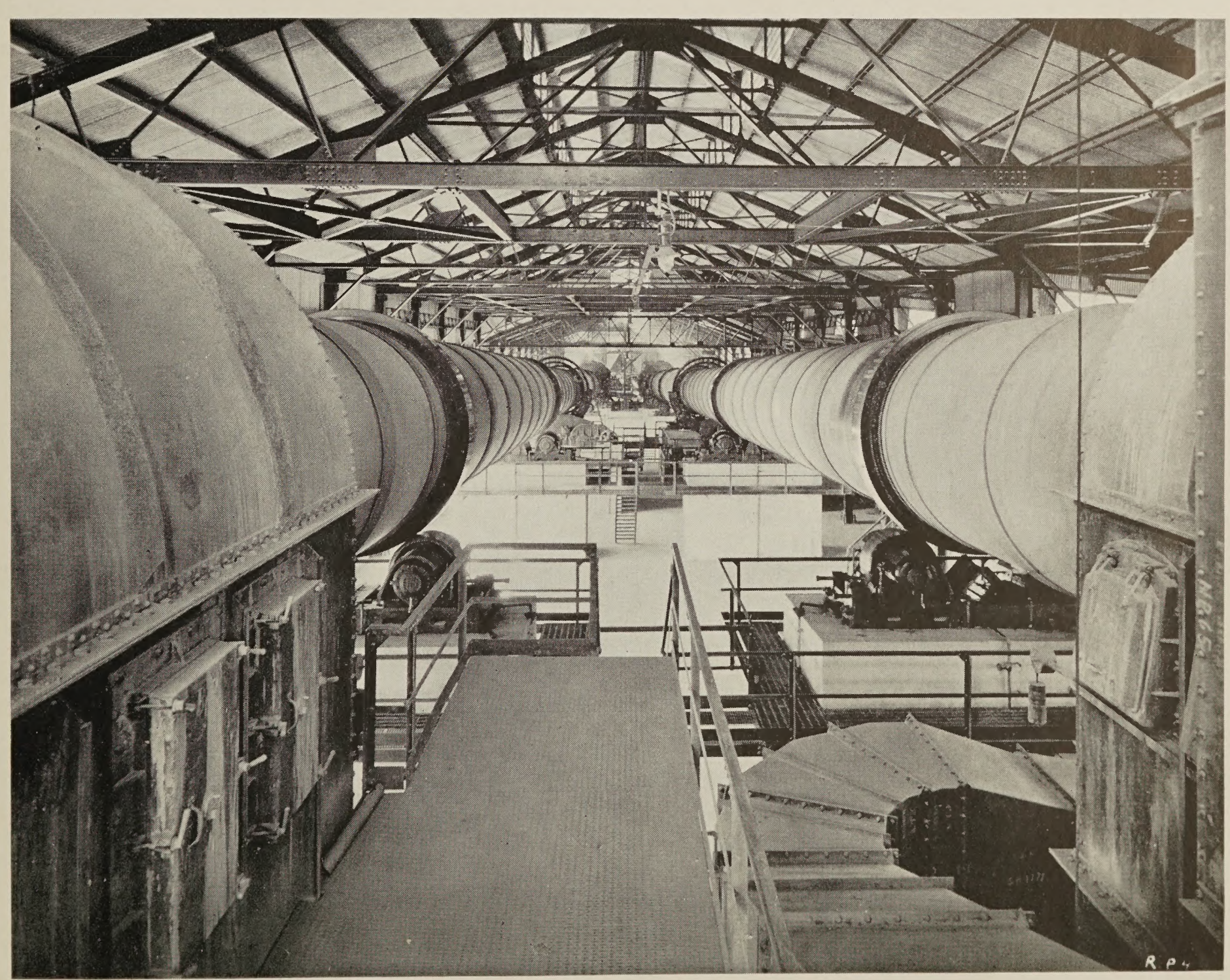
Tube mill motors and speed reduction units. Part of the main switchboard can be seen at the extreme left



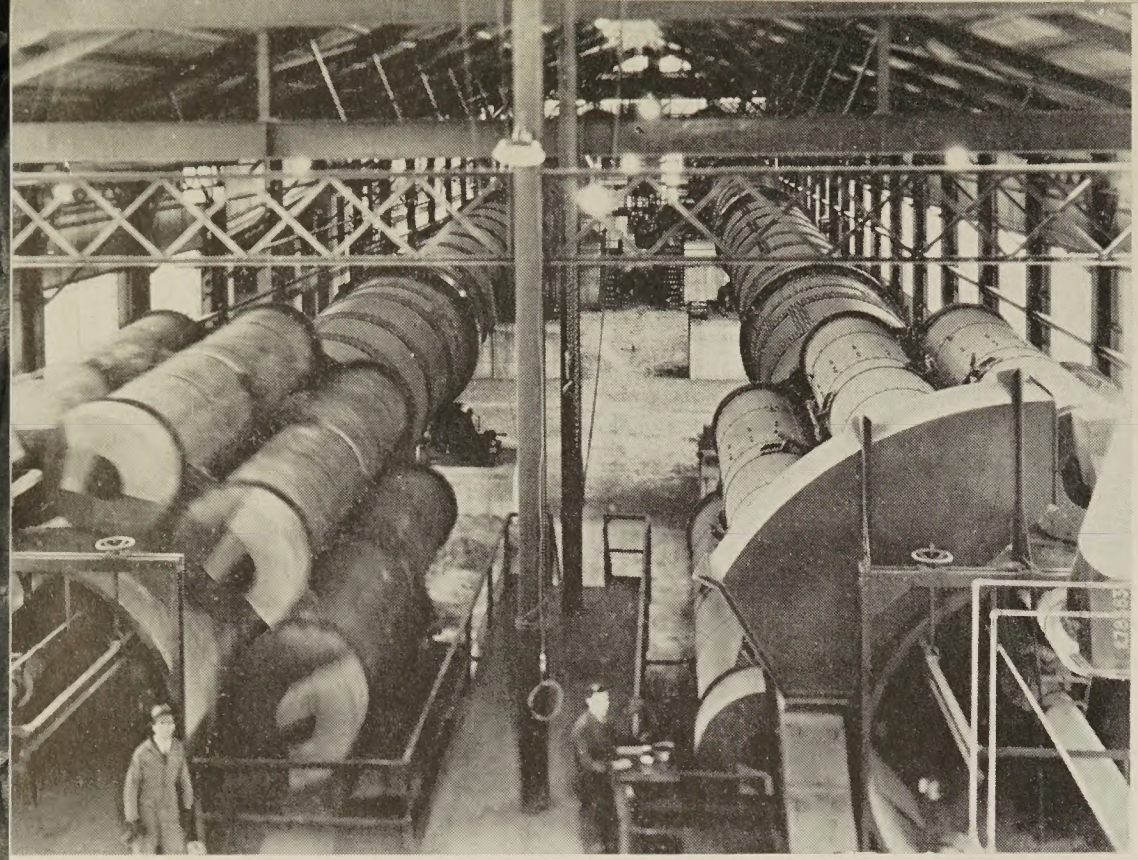


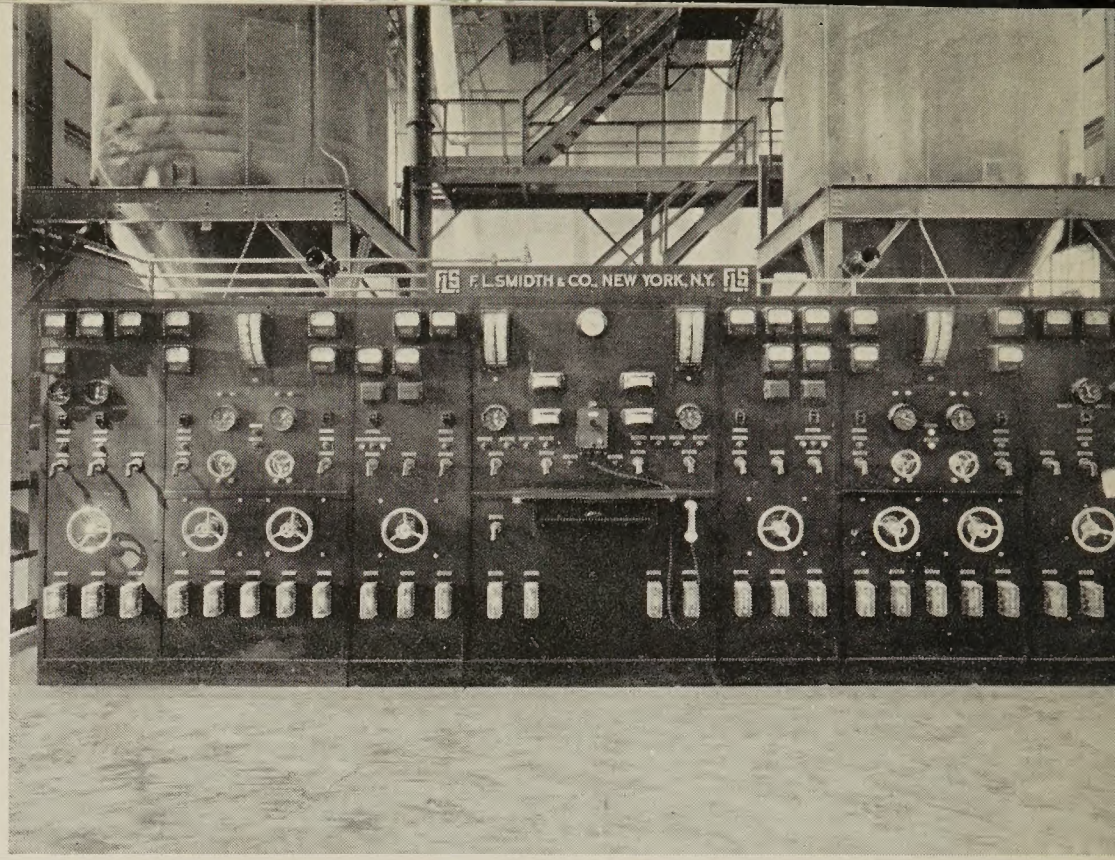
Left: Traveling agitator over the 200-ft. long slurry storage basin. Right: Seven pumps of this type handle all the slurry in the plant

deg. F. and at discharge, about 300 deg. A Smidth Skipulter receives the clinker from the kilns, discharges to another one set at right angles to it, and from this one to a Jeffrey apron conveyor leading to a Kennedy double-roll crusher. An inclosed chain-bucket elevator takes the product of the crusher to storage, from which it is reclaimed and fed to bins over the finish mills.



The two 372-ft. kilns as they look from the feed end





Left: Discharge end of the kilns showing the coolers. This view was obtained before the second kiln (right) was put into operation. Right: Control board on the firing platform of the kilns. Coal bins are shown directly behind the board

Gypsum is moved from box cars to a bin in the main storage by an inclosed bucket elevator.

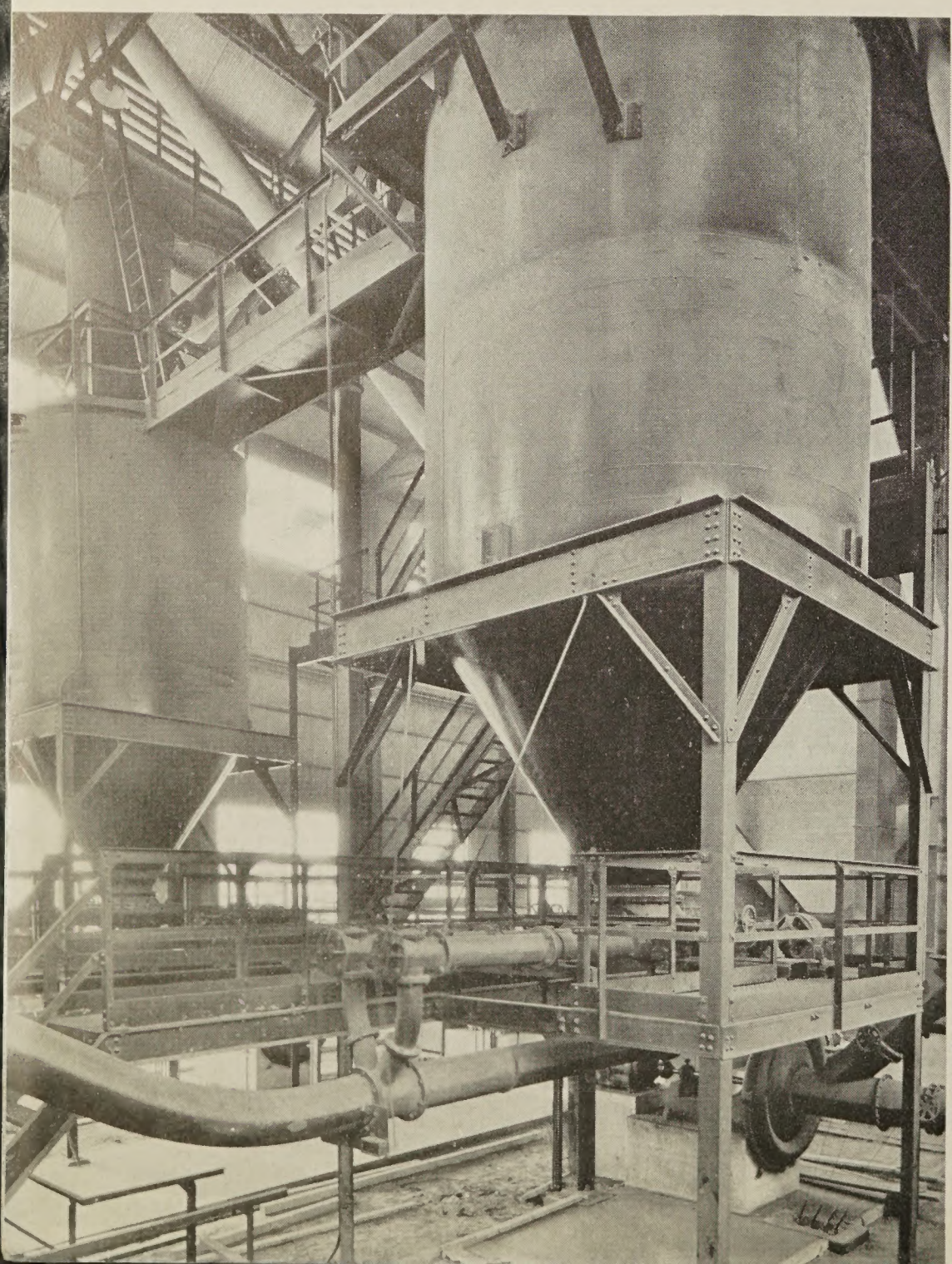
The finish mills, described previously, are especially interesting because they are equipped with air separators working in closed circuit with a cyclone-type dust collector. A combination of fans and airlocks in the system effects the passing of oversize particles back to the mills for further reduction. These units, also furnished by F. L. Smidth & Co., make possible unusually high percentages of fineness through 200- and 325-mesh.

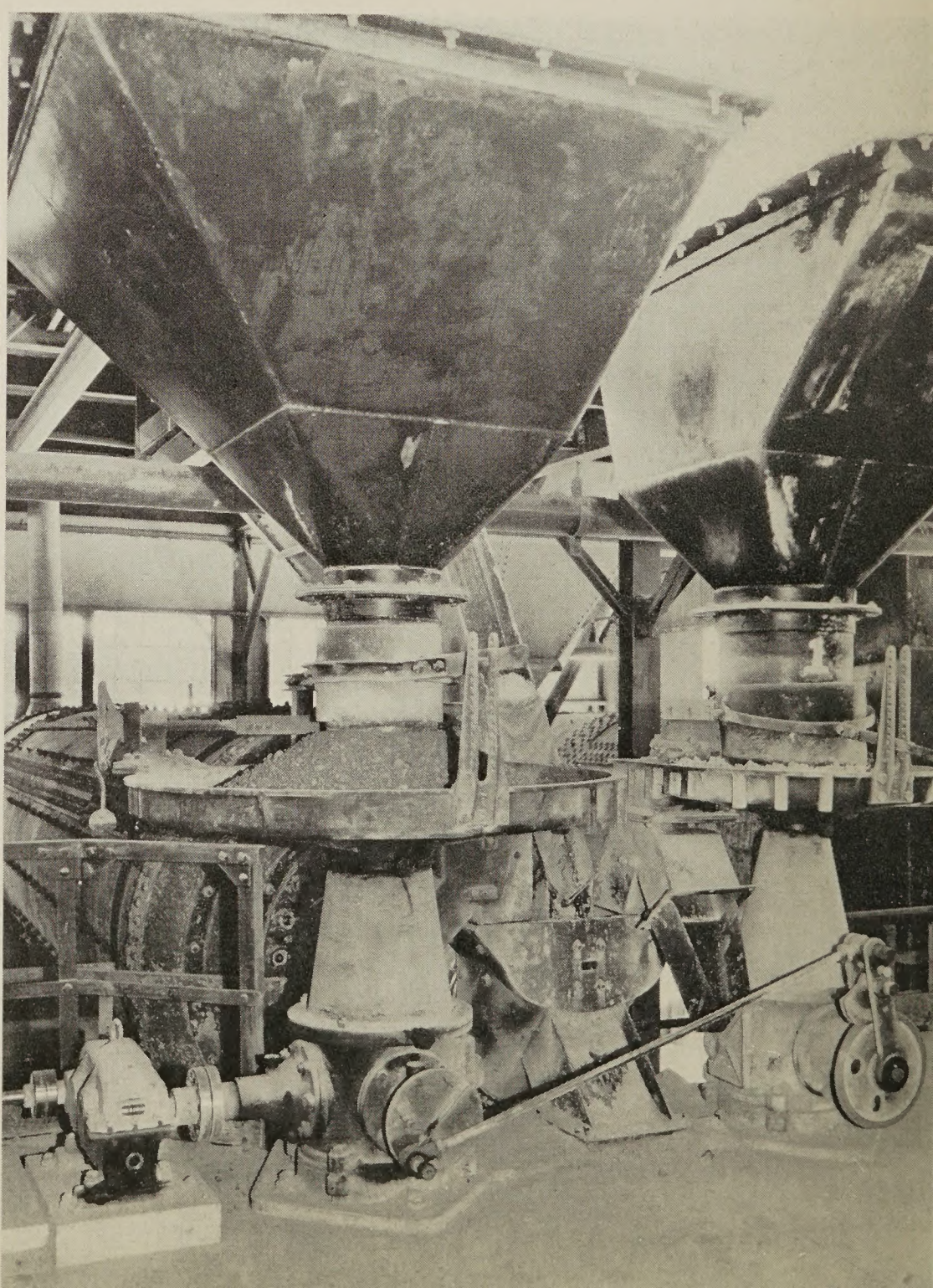
Silos and Pack House

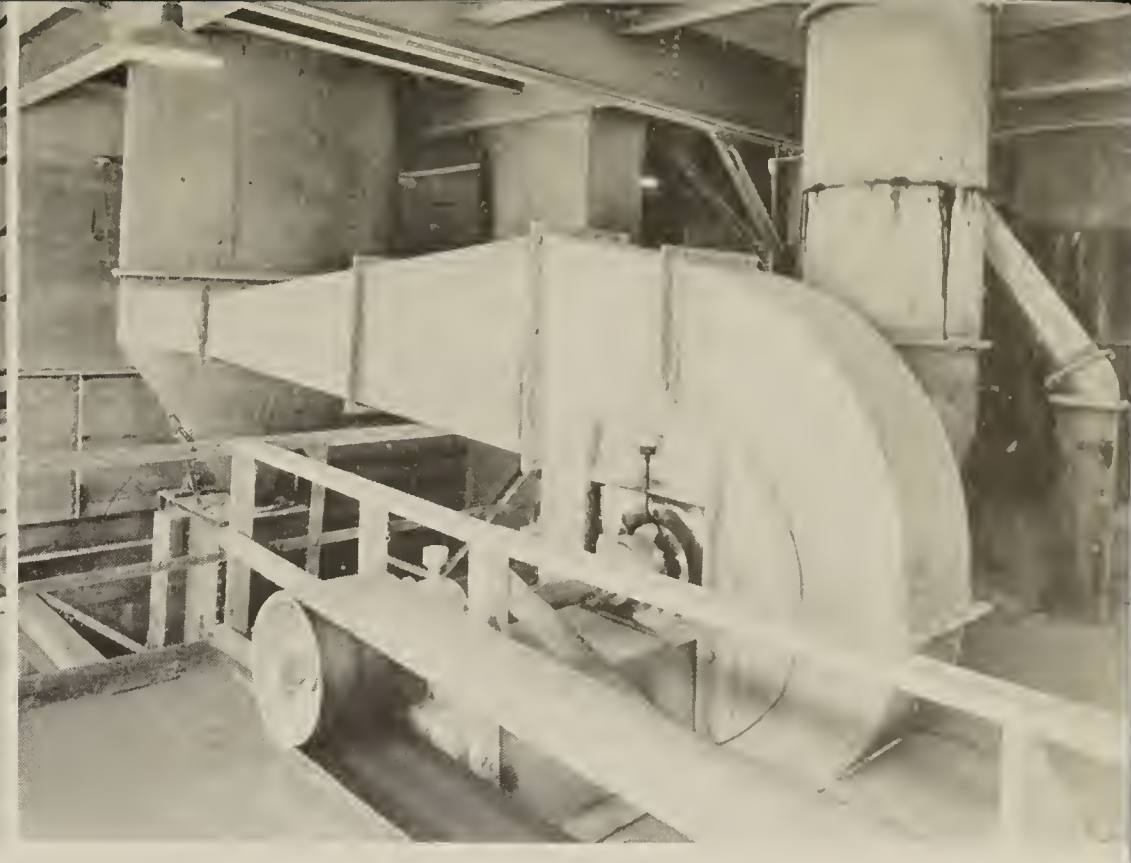
A Smidth Fluxo pneumatic duplex pump under the finish mills' storage bin conveys the cement by pipe line to the storage silos. Air pressure for it is supplied by two Fuller Co. two-stage, 750-c.f.m., rotary compressors which also supply the air for agitation in the slurry silos and storage basin. The usual system of piping atop the cement silos affords diversion to any desired silo.

The silos are in two rows of eight each with a row of five silos between. There are

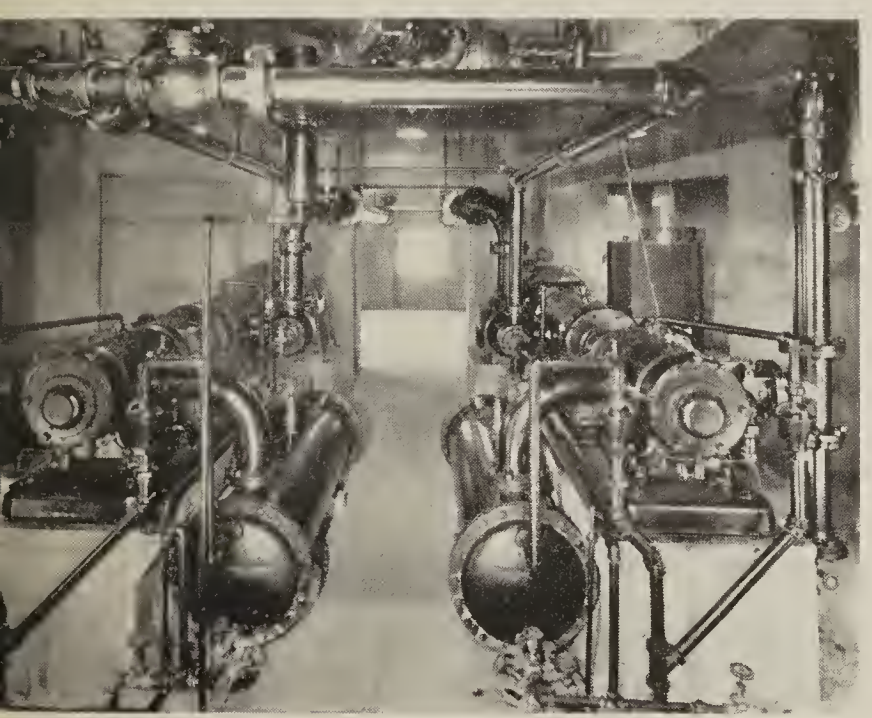
Below—Left: The 20-ton coal bins, under one of which is shown the double-screw feeders to the kiln. Right: Table feeders for clinker and gypsum on one of the finish grinding mills





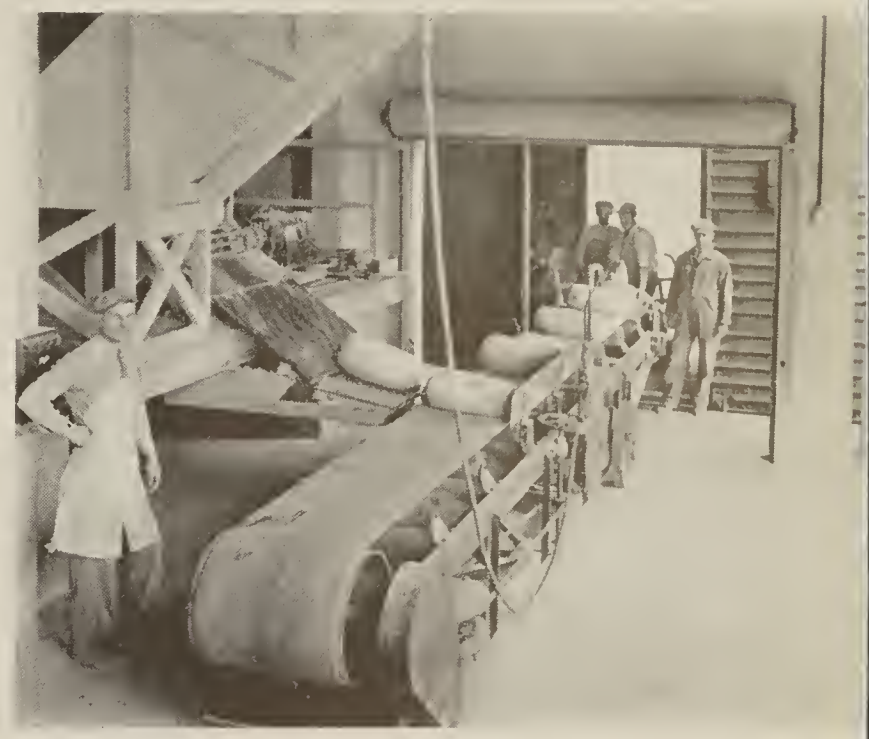


Left: The two combination coal drying and grinding mills. Right: Air separator working in closed circuit on one of the finish grinding mills



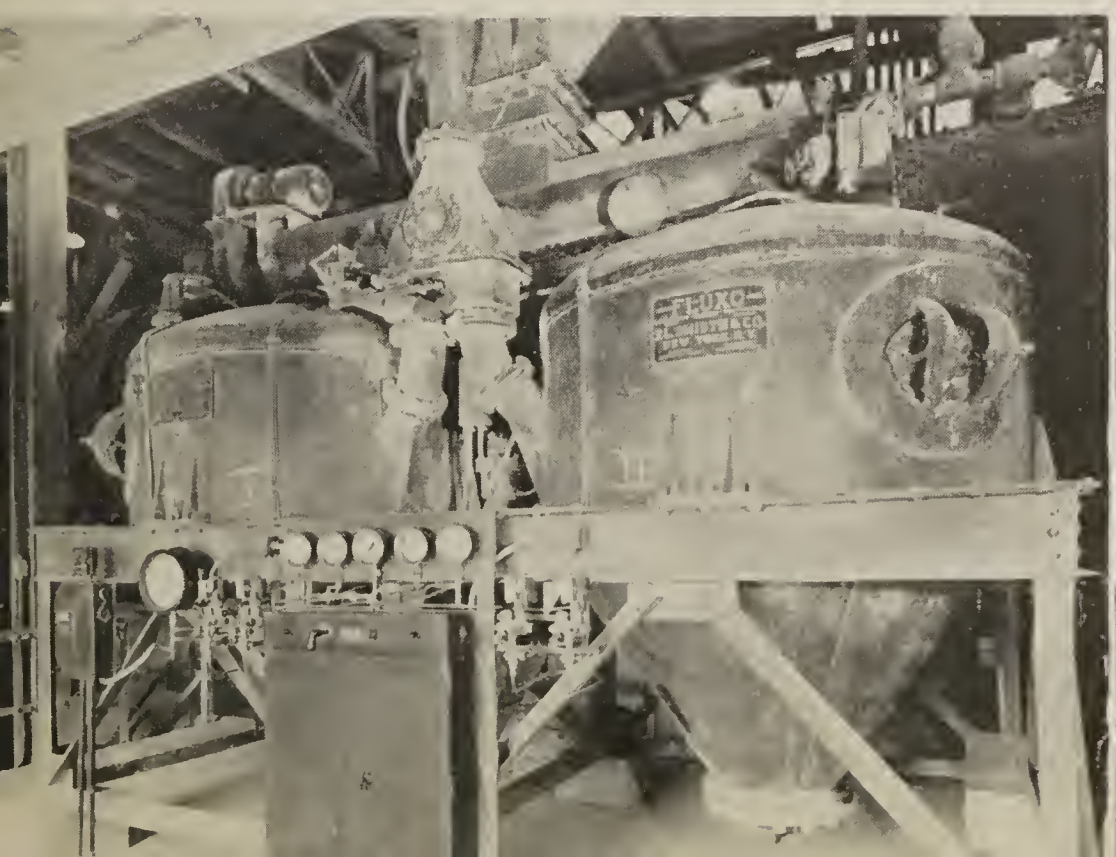
Left: Two rotary compressors furnishing air for slurry agitation and also for cement pump lines between mills and silos

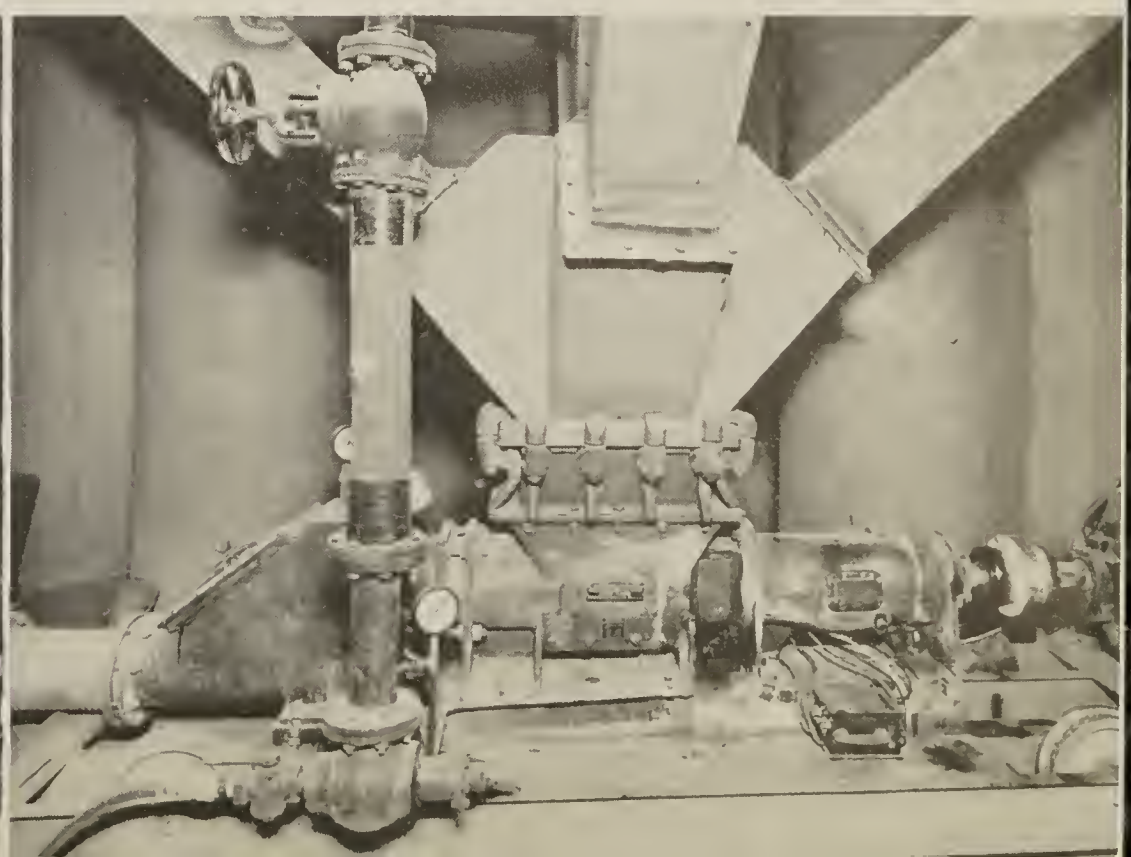
Right: Motor-driven portable conveyor for loading cars and trucks



four interspaces and these combined with the 21 silos provide a storage for 250,000 bbl. The silos are 76 ft. high and 25 ft. in diameter. Under each of the three rows is a truck-mounted, 7-in. Fuller-Kinyon cement pump, operating on track and movable to any silo in the row. These three machines pump direct to the feed bins over the bag packers. Side spouts in the silos of the two outer rows provide for bulk loading. Three Fuller rotary compressors of 500 c.f.m. capacity, supply air for agitation of cement in

Below—Left: These pumps move cement from the finish mills to silos. Right: One of the three 7-in. cement pumps under the silos





Rear view of general storage building, silos and packhouse of the National Portland Cement Co.

the pipe lines and for agitation in the feeders for the two packers.

This is one of the first plants in this country to use Smidth Fluxo bag packers. An integral part of each packer is a cylindrical feed tank, having 12 filling spouts, which revolves slowly. The operator is in a stationary position and all he has to do is fit bags on the self-sealing spouts as they come before him. These packers are rated at 1600 bags per hour. Bags are automatically fed, as filled and weighed, by gravity to motor-driven conveyors mounted on wheels, which are used for loading cars and trucks and for storing. The packers are equipped with Smidth dust collectors which discharge into the feed bins. Small Smidth Fluxo pumps return the spillage from the packers to the bins. A Modern Valve Bag Co. bag cleaner is located on the second floor and here returned bags are properly sorted, cleaned and repaired. The cleaner is equipped with a Sly dust arrester.

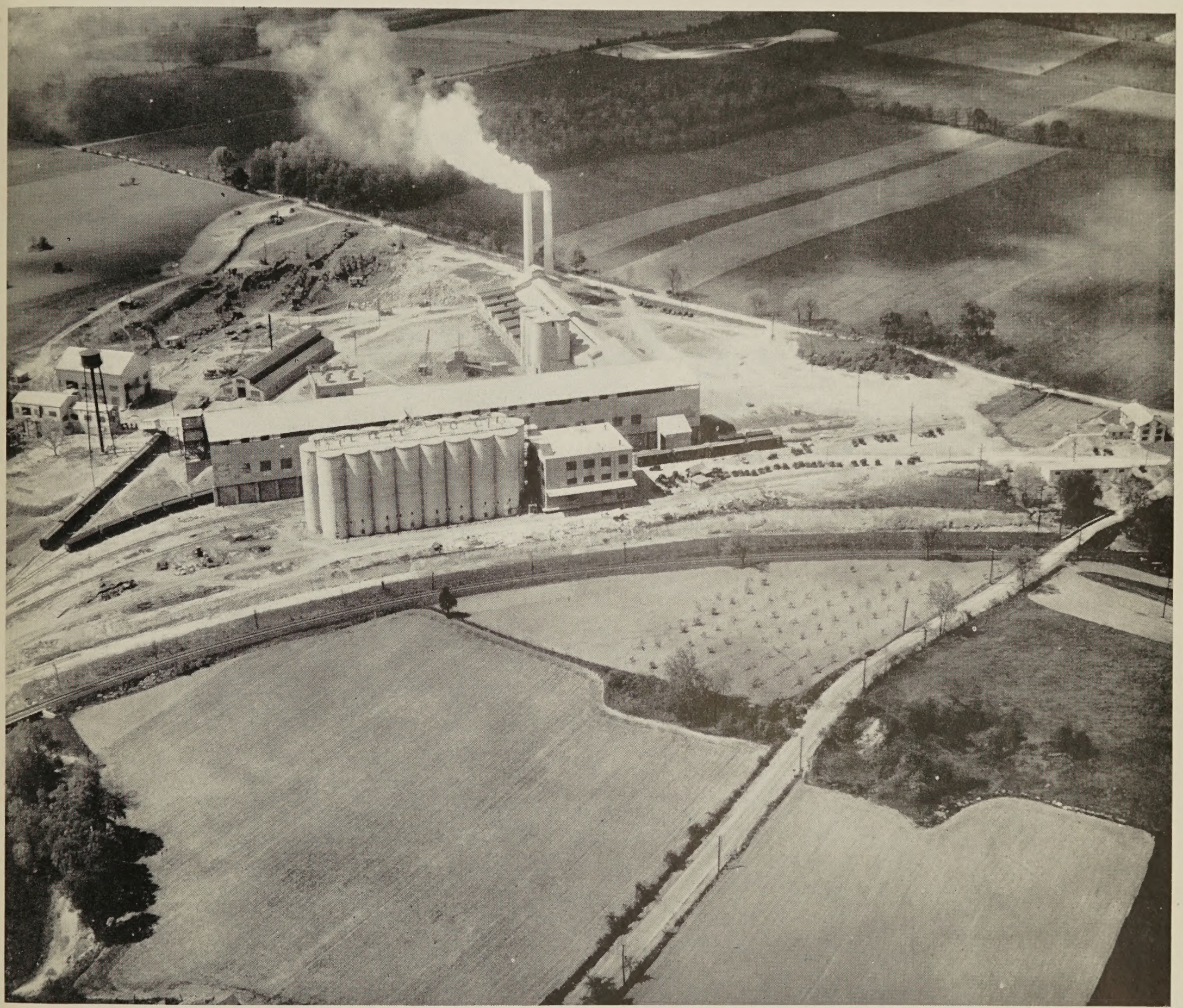
Personnel

The M. A. Long Co., Baltimore, Md., had the contract for the construction of all the buildings and foundations and made the detailed drawings. Although ground was broken for the plant in late 1933, actual construction was not started until March, 1934. Credit for its early completion is to be given the M. A. Long Co. organization, F. L. Smidth & Co., the Westinghouse Electric & Manufacturing Co., the E. M. Gilbert Engineering Corp. and the many equipment manufacturers.

In addition to the manufacturers mentioned, machinery and equipment for the plant were furnished by the Link-Belt Co. (steel inclosed chain-bucket elevators, screw-conveyors and certain drives); Merco-Nordstrom Valve Co. (valves); Worthington Pump & Machinery Co. (water pumps); Harbison-Walker Refractories Co. (fire-brick); Keasby & Mattison Co. (corrugated asbestos siding and roofing); H. H. Robertson Co. (metal roofing and siding), and the Blaw Knox Co. (steel floor and stair grating).

The officials of the company are: W. M. Richardson, president; Fred B. Franks, vice-president and general manager; John D. Shibe, treasurer; George Richardson, secretary; H. J. Larkin, assistant vice-president and assistant general manager; T. Stig-Nielsen, director; G. Larsen, director; Thomas Cunningham, director; Joseph L. Scott, director; Stephen Williams, director; Elwood Dize, director; and Arthur P. Hauser, director. A. P. Hachtmann is chief engineer; H. Hardvendel, superintendent, and Evan B. Guth, chief chemist.

Left: This photograph was taken at the time of starting the first kiln. Left to right: H. J. Larkin, Carl Grimmelman, George Richardson, Fred B. Franks, Fred B. Franks, Jr., T. Stig Nielsen and W. M. Richardson. Right: Plant office and laboratory; the first building completed



—Courtesy Dallin Aerial Surveys, Philadelphia, Penn.

Aerial view of National Portland Cement Co., Brodhead, Penn.

Cement Plant Engineering

F. L. Smidth & Co. are engineer specialists in designing and equipping factories for making Portland cement, having devoted their efforts exclusively to this industry for a period of fifty years.

Their engineering services include all stages of the project from the preliminary investigation of the site and raw material deposits, chemical and physical tests of the raw materials and finished cement, to all necessary drawings and specifications for erecting and equipping all departments of the plant, including also the electrical engineering.

This service applies equally well to complete new plants or any special department of a plant—to revisions or conversions of existing plants—making standard Portland cement, slag cements, white cement, or for making special high early strength cements, such as "VELO."

F. L. Smidth & Co.

225 BROADWAY NEW YORK, N. Y.

Cement Plant Machinery

F. L. Smidth & Co. Manufacture the Following Complete Line of Modern Cement Plant Machinery:

UNIDAN multi-compartment grinding machine.

UNIKOM multi-compartment grinding machine.

KOMINUTER for wet and dry grinding

TUBEMILL for wet and dry pulverizing.

TRIX for grading wet granulated material.

TIRAX MILL for drying and grinding coal.

PYRATOR for drying and grinding coal.

SPRAY CASINGS for pulverizers.

CYLPEBS metallic grinding bodies.

DRAGPEB metal lining for pulverizers.

SILEX flint liners for pulverizers.

SYMETRO DRIVE, speed reduction units.

FLOURMETER for determining micron sizes in finely ground cement, etc.

ROTARY KILNS for cement, lime, etc.

UNAX KILNS, with integral cooler.

UNAX COOLERS, cooling drums mounted on kiln.

UNAX GRATE COOLER, air-quenching type.

COOLERS, rotary pressure coolers.

CHAIN SYSTEM for heat economy in kilns.

KILN CONTROL, electrical, with gas analyzers.

MOLER insulating bricks for kilns, etc.

COAL FEEDERS for rotary kilns.

COAL BURNERS for rotary kilns.

GAS BURNERS for rotary kilns.

OIL BURNING EQUIPMENT for rotary kilns.

KILN EQUIPMENT, fans, hoods, dampers, spouts, airseals, dust chambers.

FLUXO PUMP for pneumatic transport.

FLUXO PACKER for filling bags.

AIR SEPARATORS and Cyclones.

EXBINER for discharging bulk cement.

SKIPULTER shaker conveyor for clinker, etc.

CYLCUP distributing conveyor.

SLURRY FEEDERS for kilns and mills.

CRADLE FEEDERS for coal, rock, clinker.

TABLE FEEDERS for coal, rock, clinker.

LENIX short center belt drive.

PUMPS for heavy liquids as cement slurry.

AGITATORS for mixing and storing wet mix.

WASHMILL for disintegrating and mixing materials in water.

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